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Matsunaga et al.

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(54) **CONNECTOR**

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(30) **Foreign Application Priority Data**

Dec. 22, 2003 (JP) 2003-425649

(51) **Int. Cl.**
H01R 13/627 (2006.01)

(52) **U.S. Cl.** **439/354**

(58) **Field of Classification Search** 439/354, 439/355, 350, 358, 353, 595
See application file for complete search history.

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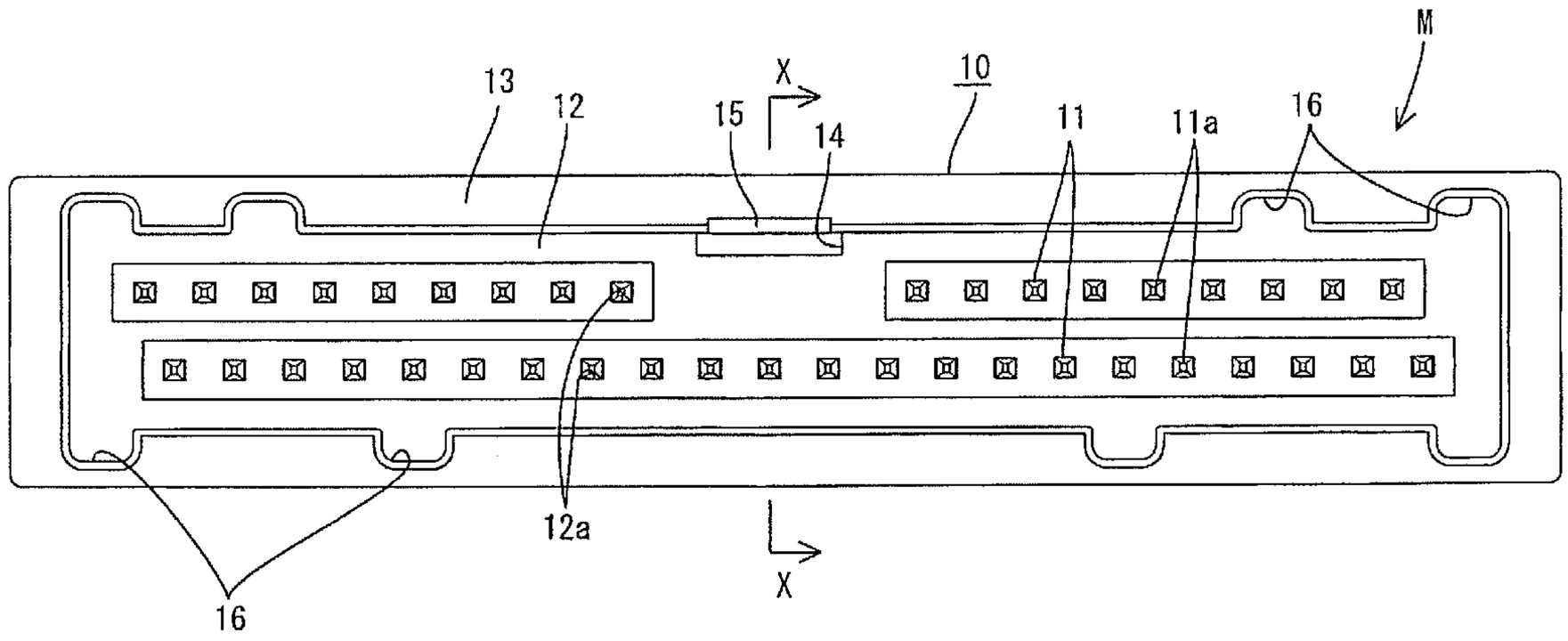
(57) **ABSTRACT**

A female housing (**20**) is provided with a lock arm (**30**) for holding a mating male connector (M) in a connected state. The lock arm (**30**) is comprised of an arm (**31**) extending along forward and backward directions and an actuator (**32**) extending along a width direction. The arm (**31**) is resiliently deformed with a support (**33**) as a supporting point and has a lock (**34**) engageable with the male connector (M). The arm (**31**) is displaced in unlocking direction by pressing the actuator (**32**). Two couplings (**35**) coupled to the female housing (**20**) are provided at opposite sides of the actuator (**32**). The couplings (**35**) are inclined up towards a widthwise middle (**32***a*) of the actuator (**32**).

9 Claims, 11 Drawing Sheets



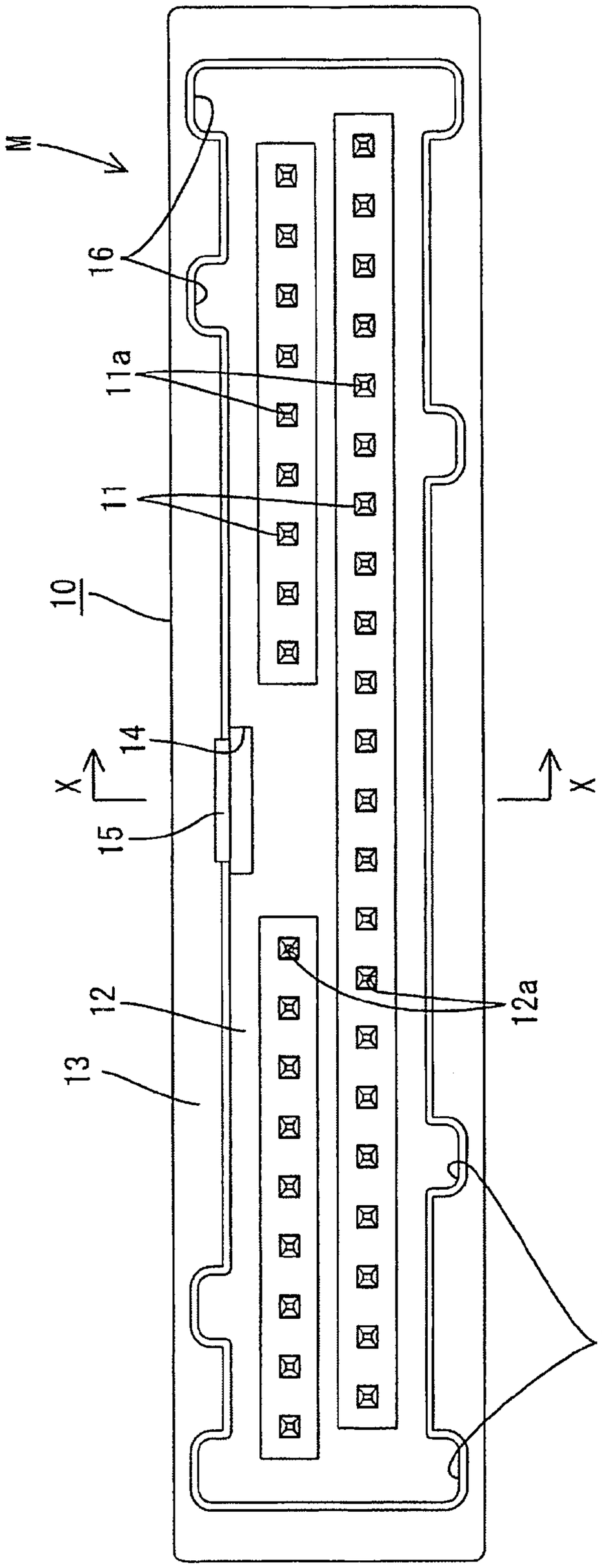


FIG. 1

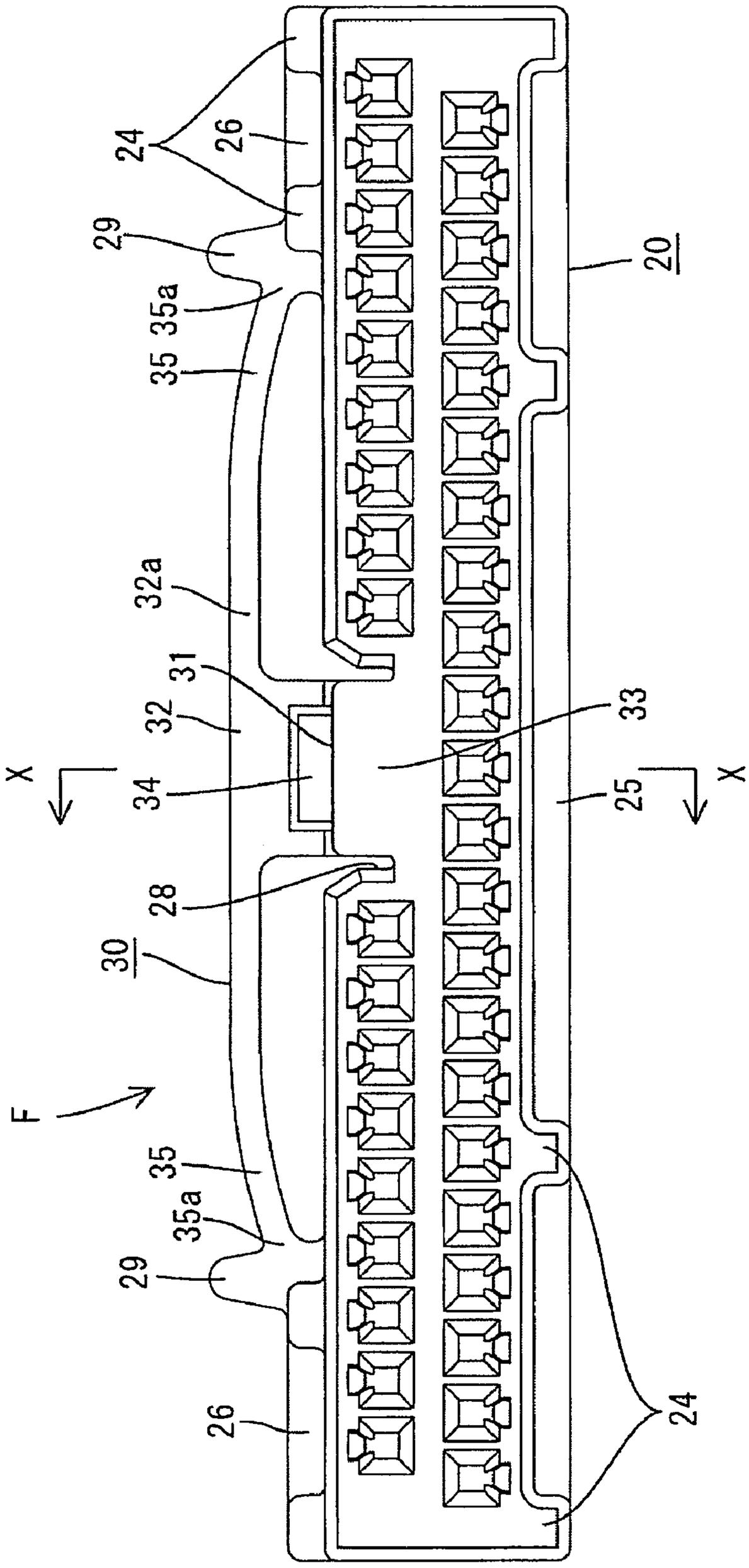


FIG. 2

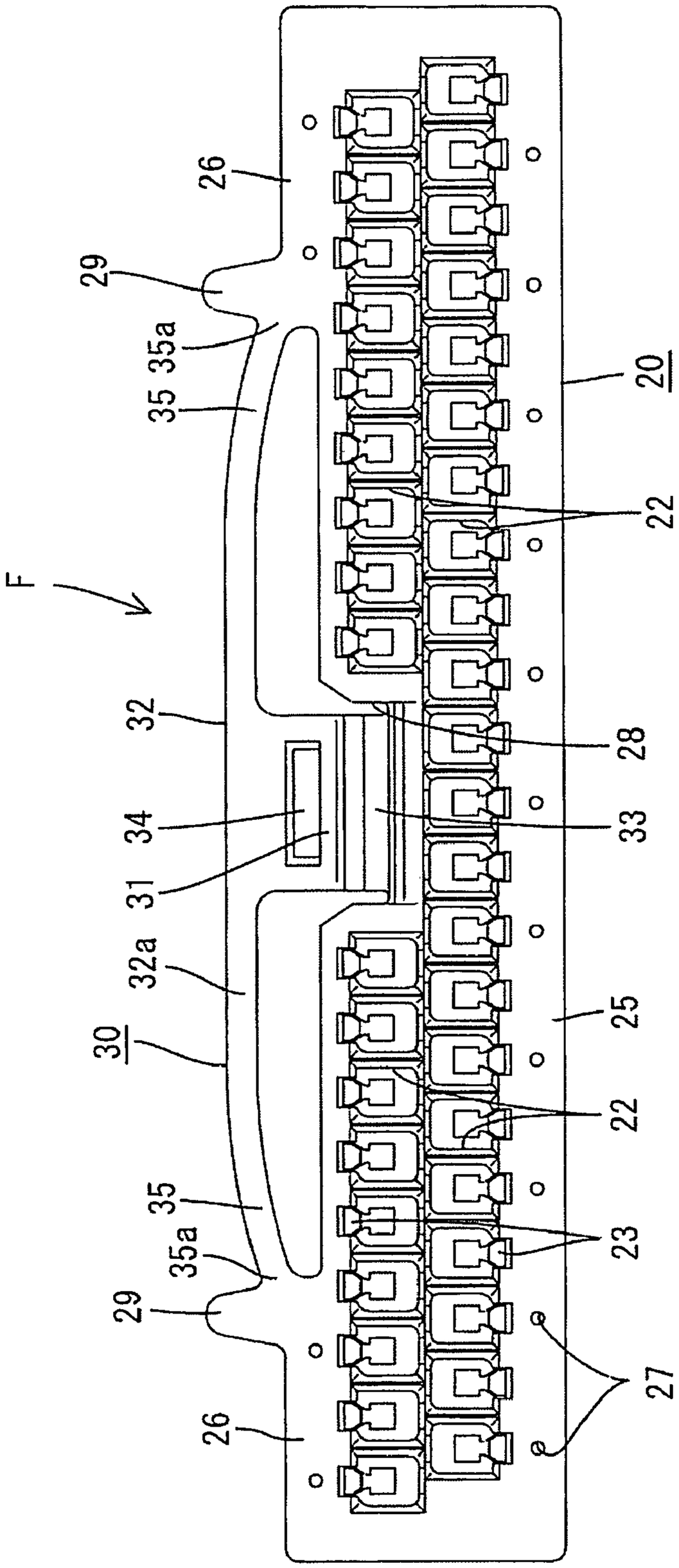


FIG. 3

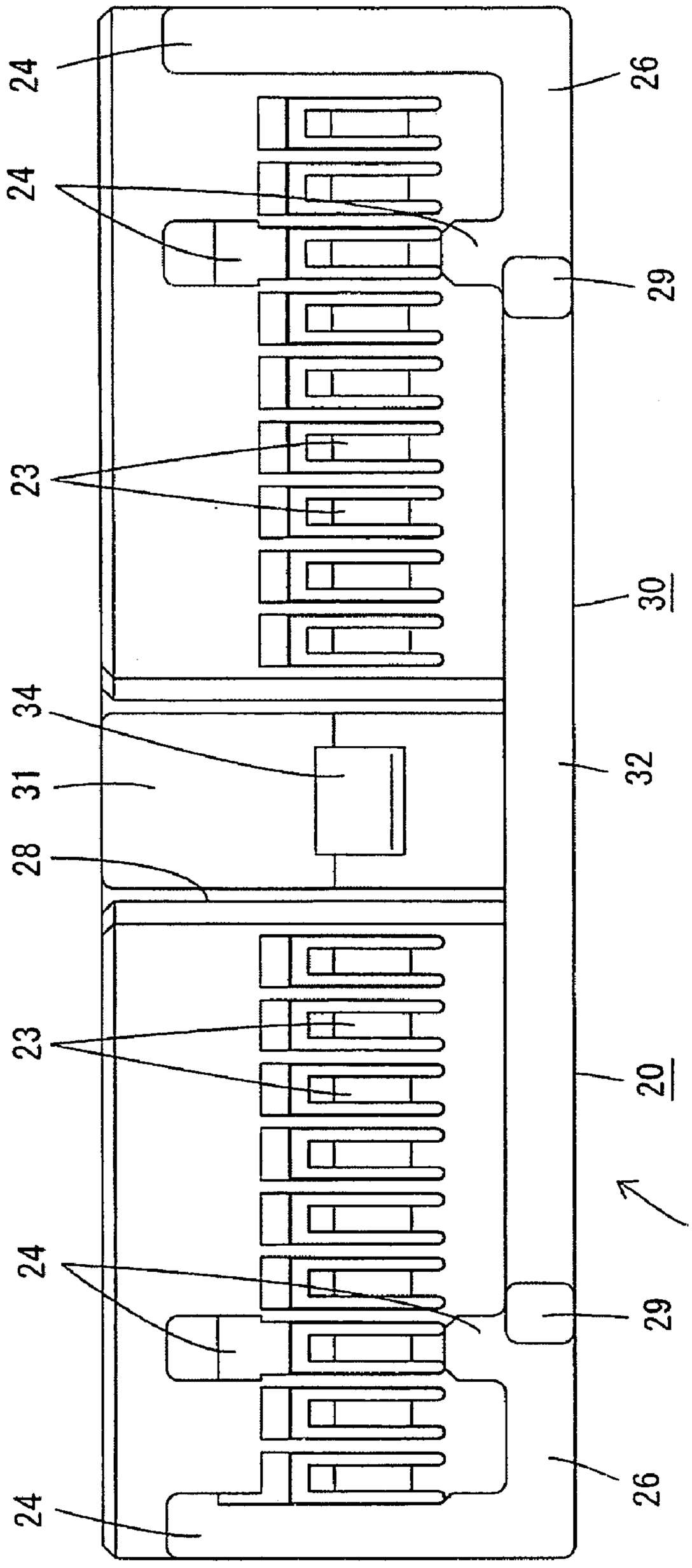


FIG. 4

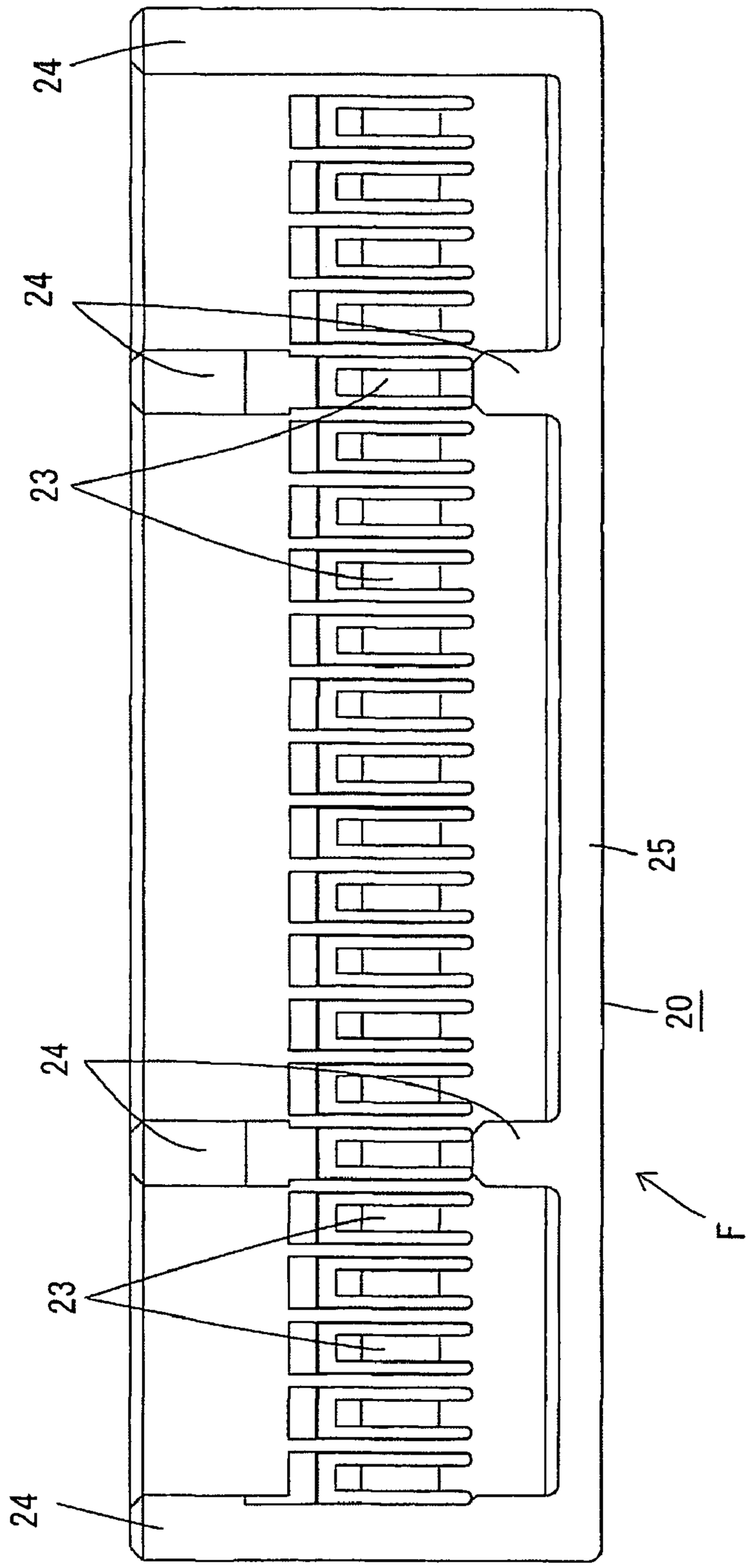


FIG. 5

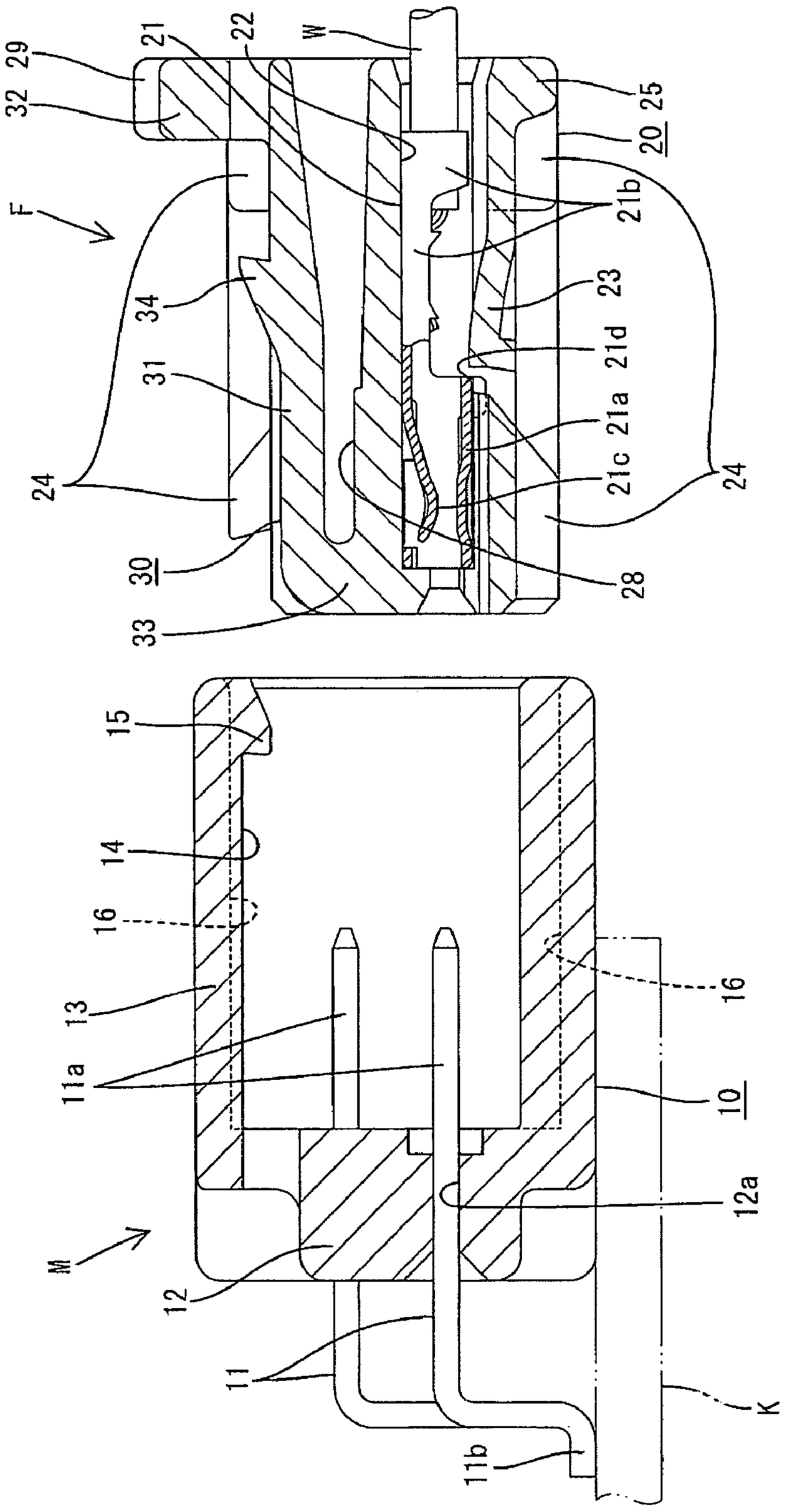

29
32
21
22
W
25
20
F
21b
34
23
31
21d
21a
21c
24
30
28
33
15
14
16
13
11a
10
12a
M
12
11
11b
K

FIG. 6

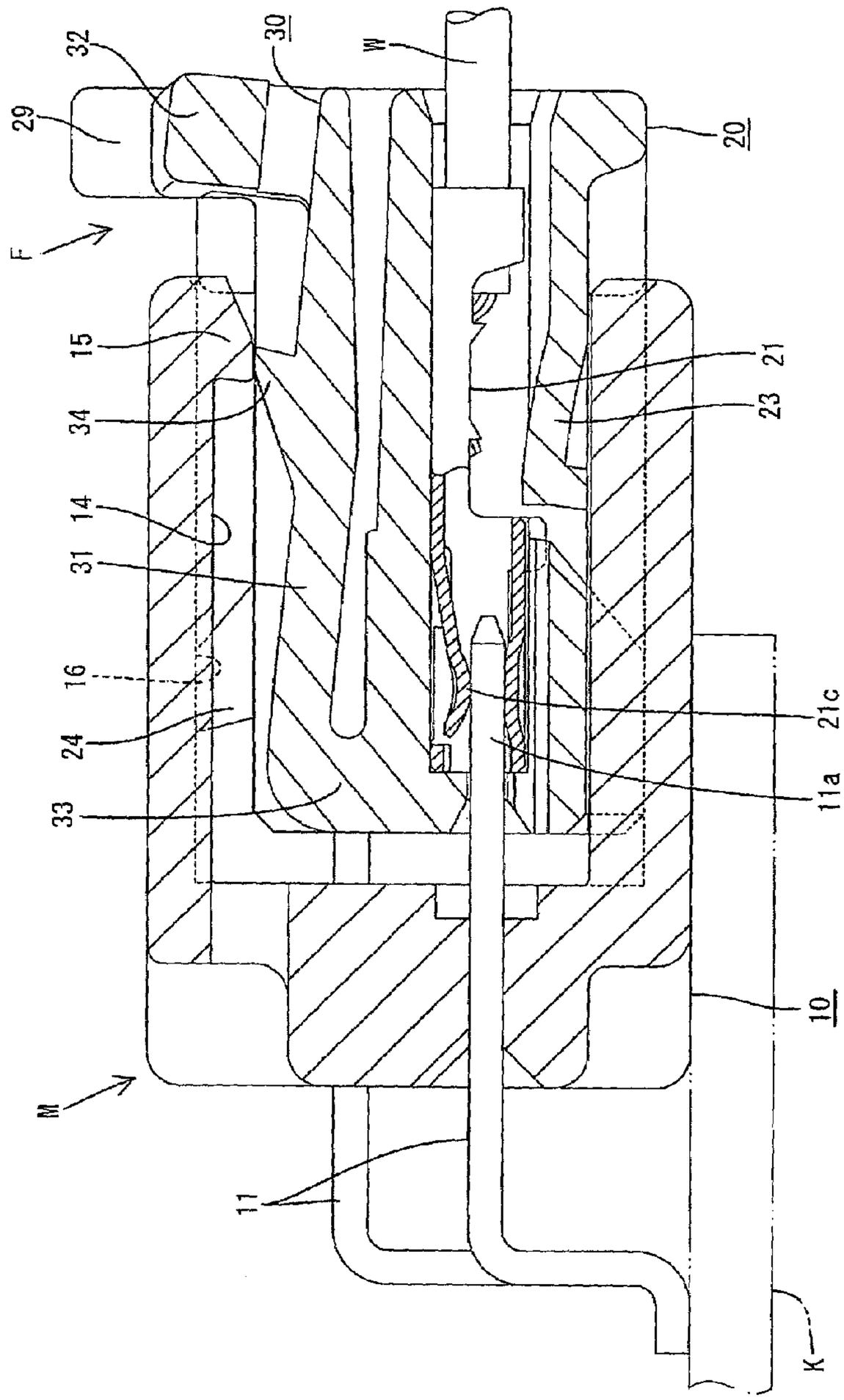


FIG. 7

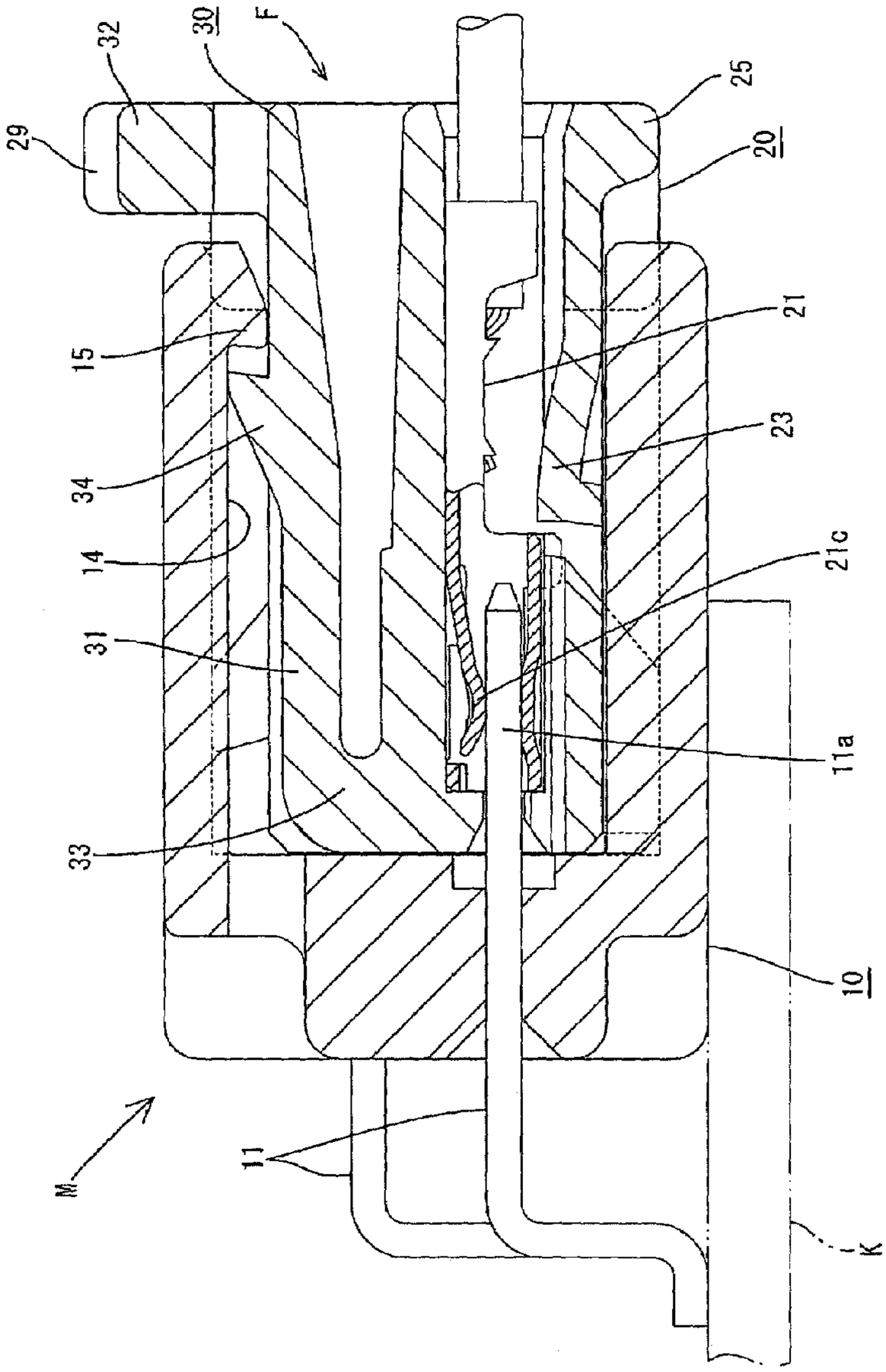


FIG. 8

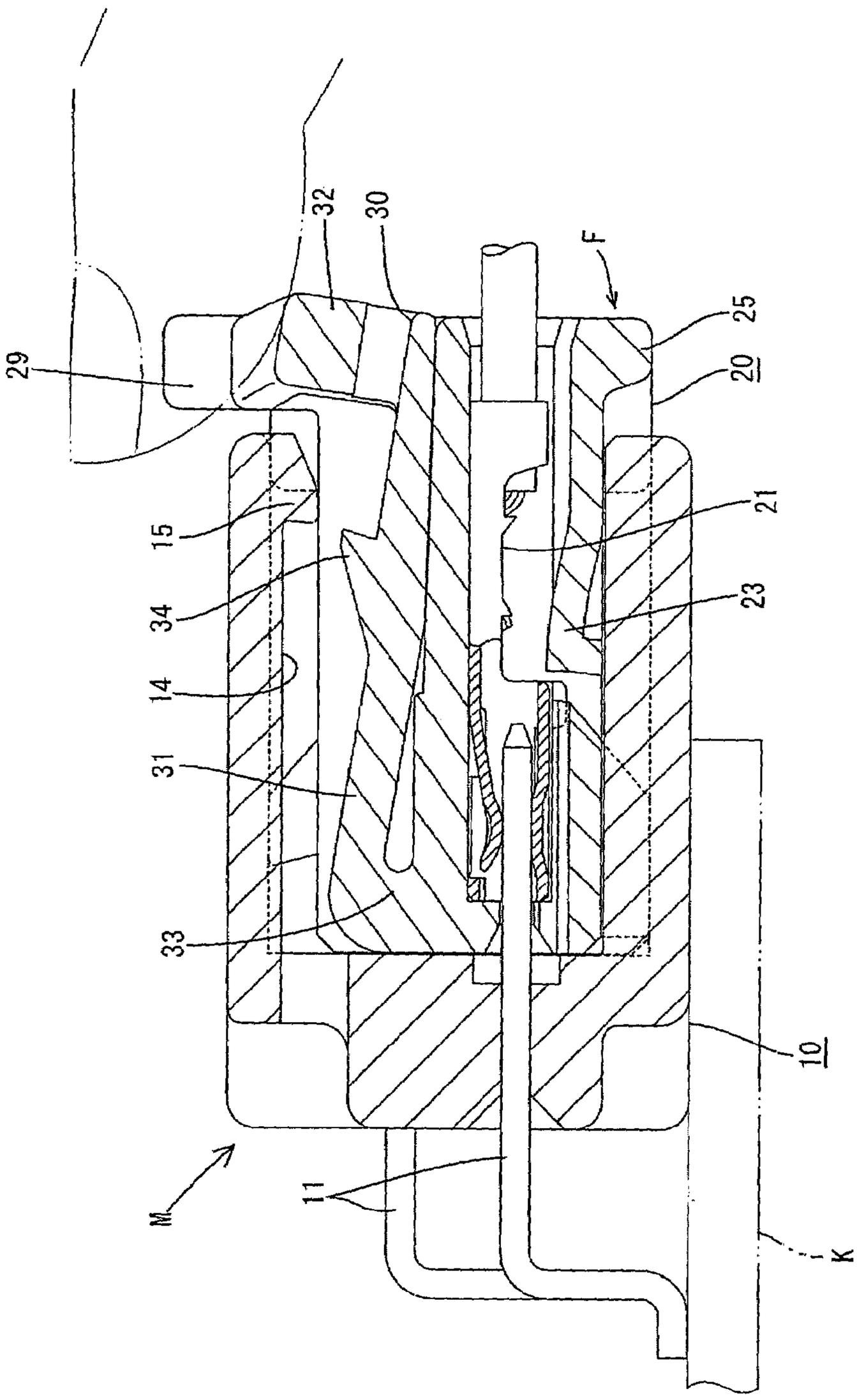


FIG. 9

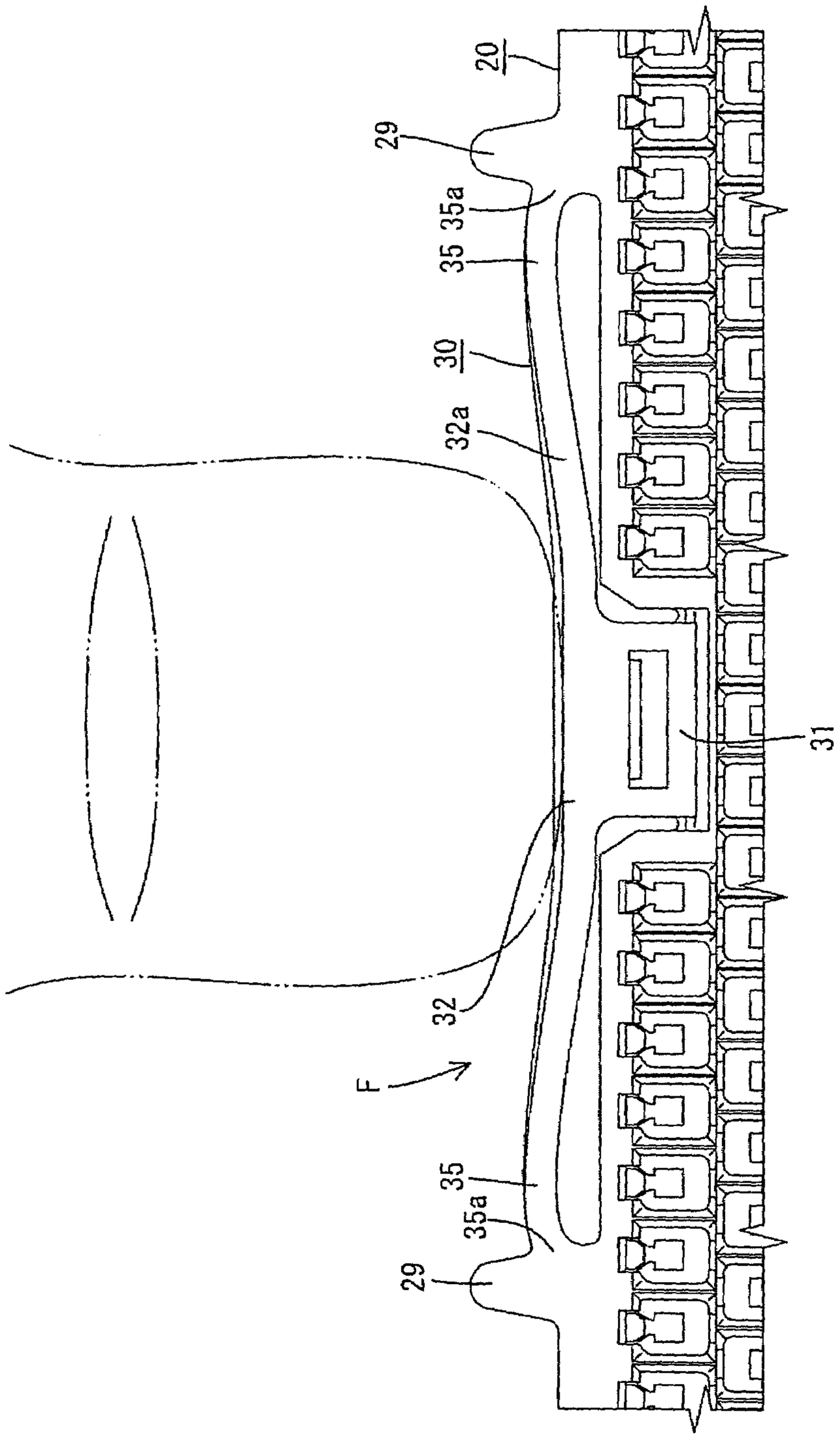


FIG. 10

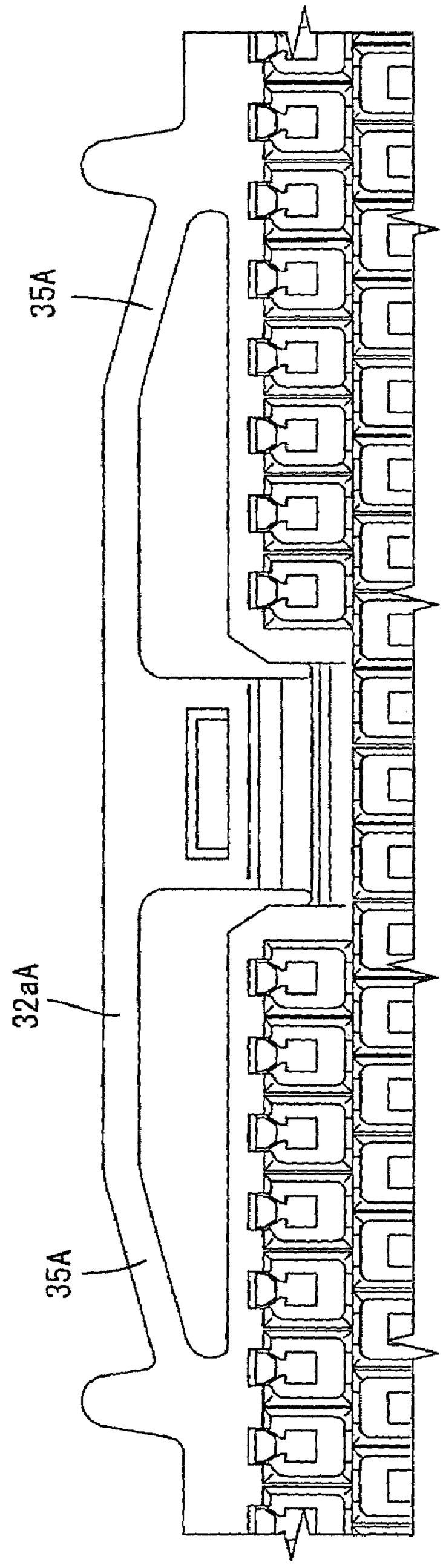


FIG. 11

CONNECTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a connector with a lock arm.

2. Description of the Related Art

Japanese Unexamined Patent Publication No. H07-282883 discloses a connector that can be connected to a mating connector. The connector has a housing and a lock arm is cantilevered from the front end of the housing. The lock arm engages an engaging portion of the mating connector to hold the connectors in the connected state.

A pressing portion is provided at the rear end of the lock arm and can be pressed from above to deform the lock arm resiliently down and so that the lock arm can be disengaged from the engaging portion. There is a demand to miniaturize the connector. However, a miniaturized version of the above-described connector would have a smaller lock arm and a smaller pressing portion. The smaller pressing portion is more difficult to press. A wider pressing portion would address this problem. However, an external wire or the like could catch a wider pressing portion. As a result, the lock arm may undergo a deformation and may be turned up by the wire or the like.

The invention was developed in view of the above problem and an object thereof is to provide a connector suitable for miniaturization.

SUMMARY OF THE INVENTION

The invention is directed to a connector with a housing that has a lock arm for holding a mating connector in a connected state. The lock arm has an arm that extends substantially along forward and backward directions. The arm is resiliently deformable about a support and has an actuator spaced from the support. A lock is formed on the arm between the support and the actuator and is engageable with the mating connector. The actuator is wider than the arm and can be pressed to displace the arm in an unlocking direction. The extension of the actuator along the width direction ensures a sufficient operable area even if the connector is small.

The lock on the arm engages the mating connector to hold the mating connector in the connected state. However, the housing can be separated from the mating connector by pressing the actuator. As a result, the arm deforms resiliently and displaced in an unlocking direction to disengage the lock from the mating connector.

Couplings are provided at the opposite ends of the actuator and are coupled to the housing. Accordingly, the arm cannot be turned up and deformed even if an external wire or the like catches the actuator.

The operation force necessary for the pressing operation may be high because the couplings are coupled to the housing. However, the couplings incline up towards the widthwise middle. As a result, the arm can deform more easily as compared to a case where the couplings are continuous and parallel with the actuator. Therefore, the connector is suitable for miniaturization.

Two protrusions preferably are provided on outer surfaces of the housing and the couplings preferably are coupled to side surfaces of the protrusions. The actuator is resiliently deformable with base ends of the couplings as supports. The supports are higher than if the coupling were joined directly to the housing. Thus, the couplings deform more easily as compared, for example, to a case where the couplings are coupled directly to the outer surface of the housing. Accordingly, the actuator can deform the arm and the couplings relatively easily.

The protrusions preferably reach a position substantially at the same height as or higher than the actuator. The actuator is protected by both protrusions.

The actuator preferably extends in a width direction over more than about half of the housing, and preferably more than about two-thirds of the width of the housing.

The couplings preferably are inclined with respect to the widthwise middle of the housing at an angle of between about 10 and 45 degrees, and preferably about 15 and 35 degrees.

The housing comprises at least one cavity for receiving at least one terminal fitting. A lock is formed in a surrounding wall of the cavity, and is resiliently deformable to engage the terminal fitting and to retain the terminal fitting in the cavity. The lock projects out beyond the outer surface of the housing in the deformed state of the lock to prevent the housing from being connected with the mating housing when the lock is in the deformed state.

A recess preferably is formed in an outer surface of the housing between two cavities, and the lock arm preferably is in the recess.

Ribs may be formed nonsymmetrically on the outer surface of the housing to prevent the housings from being connected in an improper orientation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view of a male connector according to one embodiment of the invention.

FIG. **2** is a front view of a female connector.

FIG. **3** is a rear view of the female connector.

FIG. **4** is a plan view of the female connector.

FIG. **5** is a bottom view of the female connector.

FIG. **6** is a section along **6**—**6** of FIGS. **1** and **2** showing a state before the two connectors are connected.

FIG. **7** is a section similar to FIG. **6**, but showing an intermediate stage of the connection of the two connectors.

FIG. **8** is a section similar to FIGS. **6** and **7**, but showing a state where the two connectors are properly connected.

FIG. **9** is a section similar to FIGS. **6**–**8**, but showing a state where a pressing portion is pressed at the time of separating the two connectors.

FIG. **10** is an enlarged rear view showing the state where the pressing portion is pressed at the time of separating the two connectors.

FIG. **11** is an enlarged rear view of a female connector according to another embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A connector according to a first embodiment of the invention is described with reference to FIGS. **1** to **10**. In this embodiment, a female connector F is connectable with a mating male connector M. In the following description, ends of the two connectors F, M that are to be connected are referred to as the fronts and reference is made to all the figures except FIGS. **4** and **5** concerning the vertical direction.

The male connector M is a circuit board connector that can be mounted on a circuit board K, as shown in FIG. **6**. The male connector M has a male housing **10** made of a synthetic resin and forty male terminal fittings **11** are mounted in the male housing **10**. The male housing **10**

includes a terminal holding portion **12** formed with terminal insertion holes **12***a* and the male terminal fittings **11** are insertable from behind into the terminal insertion holes **12***a*. A rectangular tubular receptacle **13** projects forward from the peripheral edge of the terminal holding portion **12**. The terminal insertion holes **12***a* are arranged side by side along widthwise direction at upper and lower stages. More specifically, twenty two terminal insertion holes **12***a* are arranged at the lower stage, and eighteen terminal insertion holes **12***a* are arranged at the upper stage. The eighteen terminal insertion holes **12***a* in the upper stage are arranged as two groups of nine terminal insertion holes **12***a* at each of the left and right sides, as shown in FIG. **1**. Further, the terminal insertion holes **12***a* at the upper stage are displaced along the width direction from the terminal insertion holes **12***a* at the lower stage. A part of each terminal fitting that projects back from the terminal holding portion **12** is bent down at a substantially right angle and then a board connecting portion **11***b* is bent substantially at a right angle again to extend back. A connecting portion **11***a* is at the front end of the male terminal fitting **11** and projects into the receptacle **13**. The board connecting portion **11***b* is connected electrically by welding or soldering with a conductor path (not shown) printed on the circuit board K.

An escaping groove **14** is formed at a widthwise middle of the upper part of the receptacle **13** and has an open rear end. An engaging portion **15** projects down at the front end of the escaping groove **14**. The rear surface of the engaging portion **15** extends substantially vertically. However, the front surface of the engaging portion **15** is sloped up towards the front. Four rib receiving recesses are formed at each of the inner upper and lower surfaces of the receptacle **13**. The male housing **10** can be fixed to the circuit board K using an unillustrated mounting member.

The female connector F has a female housing **20** made of a synthetic resin and forty female terminal fittings **21** are accommodated in the female housing **20**, as shown in FIGS. **2** to **6**. More particularly, cavities **22** are arranged side-by-side at positions corresponding to the respective terminal insertion holes **12***a* of the male connector M. Specifically, twenty two cavities **22** are arranged at the lower stage and eighteen cavities **22** are arranged at the upper stage in the female housing **20**. The eighteen upper stage cavities **22** are arranged so that nine cavities **22** are at each of left and right sides. Further, the cavities **22** at the upper stage are displaced from the cavities **22** at the lower stage along the width direction. The female terminal fittings **21** are insertable into the cavities **22** from behind. Each female terminal fitting **21** has a main portion **21***a* and a barrel **21***b* coupled one after the other. The main portion **21***a* is a box that is substantially hollow along forward and backward directions. The barrel **21***b* is crimped into connection with an end of a wire W. A resilient contact piece **21***c* is provided in the main portion **21***a* for resiliently contacting the connecting portion **11***a* of the male terminal fitting **11**.

A cantilever-shaped lock **23** is formed in a surrounding wall of each cavity **22** by forming slits in the upper wall of each cavity **22** at the upper stage or in the bottom wall of each cavity at the lower stage. The lock **23** is resiliently deformable along the vertical direction and is engageable with a jaw **21***d* of the main portion **21***a* of the female terminal fitting **21** to retain the female terminal fitting **21** in the cavity **22**. Each lock **23** is inclined to bulge out into the cavity **22** from the rear end thereof towards the free front end. The outer surface of each lock **23** is continuous with the outer surface of the female housing **20** and is exposed to the outside. The lock **23** projects more outward than the outer surface of the female housing **20** in its resiliently deformed state. Thus, if an attempt is made to connect the housings **10**, **20** in this state, this outward projecting part of the lock **23** interferes with the front end surface of the receptacle **13** to hinder the connecting operation.

Ribs **24** are provided on the upper and bottom surfaces of the female housing **20** to guide the connecting operation of the two housings **10**, **20**. More specifically, eight ribs **24** are provided at the opposite widthwise ends and two specified positions displaced towards the center from the opposite widthwise ends of each of the upper and lower surfaces. The ribs **24** extend forward from the rear end of the female housing **20**. However, intermediate portions of the ribs **24** displaced towards the widthwise center are removed because the locks **23** are exposed at the upper and lows surfaces of the female housing **20** (see FIGS. **4** and **5**). Thus, the ribs **24** towards the widthwise center are divided into front and rear sections. The upper stage ribs **24** towards the widthwise center are displaced along the width direction from the lower stage ribs **24** displaced towards the widthwise center. The front ends of the lower ribs **24** substantially align with the front end of the female housing **20**, whereas the front ends of the upper ribs **24** are retracted from the front end of the female housing **20** and the front end surfaces thereof overhang towards the front. The rear ends of the lower ribs **24** are coupled to each other by a finger placing portion **25** that extends along the width direction. The finger placing portion **25** has the same height as the ribs **24** and is formed so that an operator can place his fingers thereon while connecting and separating the female housing **20**. The finger placing portion **25** is formed over the entire width of the female housing **20** and is coupled to the ribs **24** at the opposite ends. Thus, the finger placing portion **25** contributes to the strength of the female housing **20** (see FIG. **5**). The two upper ribs **24** adjacent each end have their rear ends joined by a coupling **26** (see FIG. **4**). Marks **27** are formed by recessing in the rear end surfaces of the ribs **24**, the finger placing portion **25** and the couplings **26** for letting the operator visually confirm the positions of the cavities **22** (see FIG. **3**). It should be noted that the intervals and shape of the marks **27** can be changed from those shown.

A recess **28** is formed at the widthwise middle of the upper surface of the female housing **20** and extends the entire length of the female housing **20**. The recess **28** has a depth corresponding to the depths of the cavities **22** at the upper stage. A lock arm **30** projects in the recess **28**. The lock arm **30** includes an arm **31** and an actuator **32** that are coupled to one another. The arm **31** extends forward and backward and the actuator **32** extends along the width direction. The arm **31** has a support **33** coupled to the front end of the bottom surface of the recess **28**, and the arm **31** is resiliently deformable vertically about the support **33** (see FIG. **7**). The upper surface of the arm **31** is substantially at the same height as the upper surface of the female housing **20**. Thus, the arm **31** is at substantially the same height as the cavities **22** at the upper stage. A lock **34** projects up at a substantially longitudinal middle of the upper surface of the arm **31** (see FIG. **8**) and is engageable with the engaging portion **15** of the male connector M. Front and rear end surfaces of the lock **34** extend along the front and rear end surfaces of the engaging portion **15**. Thus, the front surface of the lock **34** slopes up towards the back and the rear surface thereof is a substantially straight vertical surface. The length of the arm **31** substantially equals the length of the female housing **20**, and the actuator **32** is coupled to the free rear end thereof.

The substantially widthwise middle of the lower surface of the actuator **32** is coupled to the upper surface of the rear end of the arm **31**. Accordingly, the arm **31** can be deformed resiliently down in the unlocking direction by pressing the actuator **32**. The actuator **32** is wider than the arm **31**. Couplings **35** are provided at the opposite ends of the actuator **32** and are coupled to the female housing **20**. Accordingly, the lock arm **30** will not turn up and deform even if an external wire or the like gets caught by the pressing portion **32**. More specifically, two protrusions **29** project up from the upper surface of the female housing **20**, and the couplings **35** of the actuator **32** are coupled to inward-facing side surfaces of the protrusions **29**. The couplings **35** are inclined up toward a widthwise middle **32***a* of the actuator **32** to define an arch shape for the actuator **32**. The widthwise middle **32***a* of the actuator **32** is substantially horizontal, whereas both couplings **35** have a substantially arcuate shape. The height of the protrusions **29** from the upper surface of the female housing **20** is higher than the highest position of the actuator **32**. Thus, the protrusions **29** protect the actuator **32**. Each protrusion **29** is narrowed gradually from the base toward the projecting end. The couplings **35** are coupled to the inward-facing side surfaces of the protrusions **29** at substantially middle positions along the height, and hence above the upper surface of the female housing **20**. Thus, the actuator **32** is resiliently deformable up and down with coupling base ends **35***a* as supports (see FIG. **10**). In this way, the lock arm **30** is supported at three points.

The female connector F is connected with the male connector M mounted on the circuit board K. An attempt could be made to connect the female housing **20** with the male housing **10** while holding the female housing **20** vertically inverted from its proper posture. However, the front ends of the ribs **24** will contact the front end of the receptacle **13** to hinder the connecting operation. As a result, an erroneous connection can be prevented.

The ribs **24** enter the corresponding rib receiving recesses **16** and guide the connecting operation smoothly when the properly held female housing **20** is fit into the receptacle **13** of the male housing **10**, as shown in FIG. **6**. The slanted front surface of the lock **34** slides in contact with the slanted front surface of the engaging portion **15** when the female housing **20** is connected to a specified depth. As a result, the lock arm **30** is deformed resiliently in the deforming direction DD, as shown in FIG. **7**. More particularly, the arm **31** is displaced down about the support **33**, and the actuator **32** is displaced down with the coupling base ends **35***a* of both couplings **35** as supports. The lock **34** reaches the escaping groove **14** when the female housing **20** is connected to a proper depth. As a result, the lock arm **30** is restored resiliently and the rear surface of the lock **34** engages the rear of the engaging portion **15** as shown in FIG. **8**. In this way, the two connectors F, M are held in their connected state. At this time, the resilient contact pieces **21***c* of the female terminal fittings **21** are held in contact with the connecting portions **11***a* of the male terminal fittings **11**.

The connectors M, F may have to be separated for maintenance. In such a case, the actuator **32** is pressed from above by fingers to deform the lock arm **30**. The arm **31** then is displaced down about the support **33**, as shown in FIG. **9**, and the actuator **32** is displaced down with the base ends **35***a* of both couplings **35** as supports. Thus, the lock **34** is displaced down from the escaping groove **14** to gradually reduce an area of engagement with the engaging portion **15** as shown in FIG. **10**. The female housing **20** is pulled back while keeping the actuator **32** pressed and soon reaches a position where the lock **34** disengages completely from the engaging portion **15**. Thus, the female connector F can be separated from the male connector M. The actuator **32** may be pressed sufficiently for the widthwise middle **32***a* to be lower than the coupling base ends **35***a* (see FIG. **10**). Fingers then can be placed on the finger placing portion **25** so that the female connector F can be pulled easily.

The actuator **32** extends along the width direction WD to ensure a sufficient pressable area. Accordingly, pressing is performed easily. The couplings **35** at the opposite ends of the actuator **32** could be coupled to the female housing **20**, and in this situation, a larger force would be necessary for the pressing operation. However, the couplings **35** are inclined up towards the widthwise middle **32***a* at an angle of between about 10 and 45 degrees and preferably between about 15 and 35 degrees. Thus, the actuator **32** can be deformed more easily than a case where the couplings are parallel with the widthwise middle. Thus, pressing ease is reduced only to a slight extent. In addition, both couplings **35** of the actuator **32** are coupled to the side surfaces of the protrusions **29** at intermediate height positions, and the actuator **32** is deformed resiliently with the coupling base ends **35***a* as supports. Thus, the supports are higher at the time of the resilient deformation and the actuator **32** can deform relatively easily as compared to a case where the couplings are coupled directly to the outer surface of the female housing.

The invention is not limited to the above described and illustrated embodiment. For example, the following embodiments are also embraced by the technical scope of the present invention as defined by the claims. Beside the following embodiment, various changes can be made without departing from the scope and spirit of the present invention as defined by the claims.

The mode of the pressing portion can be changed. Specifically, as shown in FIG. **11**, couplings **35**A are coupled to a widthwise middle portion **32***a*A and extend obliquely and straight instead of being arcuate. As another mode, the widthwise middle may have a shape other than the horizontal shape. As another mode, the entire pressing portion may, for example, extend slightly oblique to widthwise direction.

The mode of the arm can also be changed. For example, the arm may extend slightly oblique to forward and backward directions or may be seesaw-shaped by having the support coupled to a position other than the front end of the arm.

Although the arm and the pressing portion are coupled to each other in the foregoing embodiment, they may be separate from each other according to the present invention. Further, the protrusions may have substantially the same height as or may be lower than the actuator or may be omitted according to the present invention.

The male connector is fixed to the circuit board in the foregoing embodiment. However, the male connector may be provided at ends of wires.

The female connector has the lock arm in the foregoing embodiment. However, the male connector may be provided with the lock arm according to the invention. Further, the number and arrangement of the respective terminal fittings can be changed.

What is claimed is:

1. A connector having a housing with opposite front and rear ends defining forward and backward directions and opposite sides defining a width direction, a lock arm for holding a mating connector in a connected state, the lock arm comprising an arm joined to the housing at a support and extending from the support substantially along the

forward and backward directions, a lock formed on the arm and configured for engagement with the mating connector, an actuator joined to the arm and extending substantially along the width direction, the arm being resiliently deformable about the support in an unlocking direction in response to pressing forces on the actuator, and two couplings coupled to the housing at opposite sides of the actuator and inclined up towards a widthwise middle of the actuator, wherein two protrusions are provided on an outer surface of the housing, the couplings being coupled to side surfaces of the protrusions, and the actuator being resiliently deformable with coupling base ends of the couplings as supports.

2. The connector of claim **1**, wherein both protrusions are formed to reach a position at least as high as the actuator.

3. The connector of claim **1**, wherein the actuator extends substantially along the widthwise direction over more than about half of the width of the housing.

4. The connector of claim **1**, wherein the couplings are inclined towards a widthwise middle by an angle between about 10° and 45°.

5. The connector of claim **1**, wherein the housing comprises cavities arranged on at least one stage for receiving terminal fittings, wherein a lock is formed in a surrounding wall of the cavity and is resiliently deformable to be engageable with the terminal fitting to retain the terminal fitting in the cavity.

6. The connector of claim **5**, wherein the lock projects more outward than the outer surface of the housing in its resiliently deformed state, so that if an attempt is made to connect the housing with the mating housing in this state, this outward projecting part of the lock interferes with the mating housing to hinder the connecting operation.

7. The connector of claim **6**, wherein a recess having a depth substantially corresponding to the cavities is formed over substantially the entire length at a substantially widthwise middle position of the outer surface of the housing, and the lock arm projects there.

8. The connector of claim **1**, wherein ribs are provided on the housing in an asymmetric way to hinder the connection of the housing being improperly oriented with the mating housing.

9. A connector having a housing with opposite front and rear ends and a plurality of surrounding walls extending in forward and backward directions between the front and rear ends, cavities extending through the housing between the front and rear ends for receiving terminal fittings, resiliently deflectable locks formed in the surrounding walls and projecting at least partly into the respective cavities, the locks deflecting outwardly from the surrounding walls during insertion of the terminal fittings into the respective cavities and returning resiliently into alignment with the surrounding walls for engaging the terminal fitting that has been inserted completely into the respective cavity, whereby an outward projecting part of the lock interferes with the mating housing to hinder a connecting operation if any one of the terminal fittings is not inserted completely, wherein two protrusions are provided on an outer surface of the housing, the couplings being coupled to side surfaces of the protrusions, and the actuator being resiliently deformable with coupling base ends of the couplings as supports.

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